Integration of Pen-based Computer Technology in Clinical Settings

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In this demonstration, we will show how a set of existing or emerging technologies, particularly pen-based, mobile devices, could be applied to facilitate clinical tasks, including information access at the point of care.

Although clinical work is highly information intensive, few care providers are using computers in the clinical setting. A major reason for this has been the mismatch between the mobile clinician and the fixed computer workstation. Clipboard sized computers controlled via a pen-like stylus are making it possible to bring computers to clinicians. Making the computers a useful tool for the clinicians is the next challenge.

Integrating computerized tools into the highly evolved, time-critical pattern of the clinical environment is much more difficult than computing on the desktop. When sitting at a desk working with a computer, the user is generally focused on the computer, working on a task that is entirely embedded in the computer. In this setting, people seem to be tolerant of delays, complicated user interfaces, and large, noisy hardware devices such as keyboards and CRTs. In contrast, the clinician is focused on a task which is mostly external to the computer. In fact, the clinician would prefer to view the computer as a tool, just like a stethoscope or hammer, which are quick to hand, simple to use, effective, and out of the way when not being used.

This gives rise to several characteristics that are likely to be important in software systems that achieve broad clinical success. First, the system must be *responsive.* With thirty or more patients a day, every second counts. Of course, fast hardware is important, but careful software design plays as important a role. Good algorithms and careful coding are the first step. In client-server systems, delays can often be avoided by caching data from the server and pre-fetching potentially relevant data when the system is otherwise idle.

The system should be *flexible* to the user's needs. Physicians are often interrupt-driven and would be very unhappy if unable to switch patients in mid-exam. The system should allow the user to move freely between tasks (patient A, patient B, e-mail, schedule, phone, etc.), preserving the context of the idle tasks. This means no so-called system modal dialogs that lock-out the user from doing anything else until some task is complete. This characteristic is also important when responsiveness is less than ideal. There's nothing more frustrating than wanting to send e-mail while the computer is busy copying a file and has locked you out.

Any clinical system must be *simple to use.* Physicians already have enough to keep track of without adding complicated computer interfaces. Simple does not mean that the system should have its hands tied behind its back, however. By taking a small set of core concepts, such as a few pen gestures, buttons, and dialogs, and using them consistently it should be possible to build interfaces that convey data clearly, are self-prompting (i.e. it is clear to the user what actions are available), and provide the user with a complete set of relevant actions.

The various components of a clinical software system must be highly *integrated.* By having modules that talk to each other, a lot of work can be saved. At the most basic level, this means copying patient names to prescription forms. In a more advanced form, it could mean presenting the results of decision-support agents within the context of the medical record.

In considering these issues, we have developed a simple scenario-based mock-up to illustrate how interactions with an advanced clinical system could appear from the clinician's perspective. The mock-up is organized around a the longitudinal care of an oncology patient, and the clinicians caring for him.

We show how electronic mail, filtered for urgency and delivered via a wireless network, can substitute for urgent but routine communications. We demonstrate a mechanism for recording medical findings that balances the inherently complex space of discourse of medical progress notes against the need for a simple user interface and capturing structured information. We show how medical reference knowledge sources can be seemlessly and efficiently accessed from the problem-list of the medical record, with data from the medical record being used to facilitate searching literature. Finally, we show how a decision support agent, in this case one that matches clinical trials with potentially eligible patients, can be used to support clinical care.

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